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APPLICATION NO.	FILING DATE	FIRST NAMED INVENTOR	ATTORNEY DOCKET NO.	CONFIRMATION NO.
10/784,947	02/25/2004	Masahiro Totsuka	402986	8433

23548 7590 08/04/2005

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EXAMINER	
AU, BAC H	

ART UNIT	PAPER NUMBER
2822	

DATE MAILED: 08/04/2005

Please find below and/or attached an Office communication concerning this application or proceeding.

Office Action Summary	Application No.	Applicant(s)	
	10/784,947	TOTSUKA ET AL.	
	Examiner	Art Unit	
	Bac H. Au	2822	

-- The MAILING DATE of this communication appears on the cover sheet with the correspondence address --

Period for Reply

A SHORTENED STATUTORY PERIOD FOR REPLY IS SET TO EXPIRE 3 MONTH(S) FROM THE MAILING DATE OF THIS COMMUNICATION.

- Extensions of time may be available under the provisions of 37 CFR 1.136(a). In no event, however, may a reply be timely filed after SIX (6) MONTHS from the mailing date of this communication.
- If the period for reply specified above is less than thirty (30) days, a reply within the statutory minimum of thirty (30) days will be considered timely.
- If NO period for reply is specified above, the maximum statutory period will apply and will expire SIX (6) MONTHS from the mailing date of this communication.
- Failure to reply within the set or extended period for reply will, by statute, cause the application to become ABANDONED (35 U.S.C. § 133). Any reply received by the Office later than three months after the mailing date of this communication, even if timely filed, may reduce any earned patent term adjustment. See 37 CFR 1.704(b).

Status

1)☒ Responsive to communication(s) filed on *25 February 2004*.

2a)☐ This action is **FINAL**. 2b)☒ This action is non-final.

3)☐ Since this application is in condition for allowance except for formal matters, prosecution as to the merits is closed in accordance with the practice under *Ex parte Quayle*, 1935 C.D. 11, 453 O.G. 213.

Disposition of Claims

4)☒ Claim(s) *1-7* is/are pending in the application.

4a) Of the above claim(s) _____ is/are withdrawn from consideration.

5)☐ Claim(s) _____ is/are allowed.

6)☒ Claim(s) *1-7* is/are rejected.

7)☐ Claim(s) _____ is/are objected to.

8)☐ Claim(s) _____ are subject to restriction and/or election requirement.

Application Papers

9)☐ The specification is objected to by the Examiner.

10)☒ The drawing(s) filed on *25 February 2004* is/are: a)☒ accepted or b)☐ objected to by the Examiner.

Applicant may not request that any objection to the drawing(s) be held in abeyance. See 37 CFR 1.85(a).

Replacement drawing sheet(s) including the correction is required if the drawing(s) is objected to. See 37 CFR 1.121(d).

11)☐ The oath or declaration is objected to by the Examiner. Note the attached Office Action or form PTO-152.

Priority under 35 U.S.C. § 119

12)☐ Acknowledgment is made of a claim for foreign priority under 35 U.S.C. § 119(a)-(d) or (f).

a)☐ All b)☐ Some * c)☐ None of:

1.☐ Certified copies of the priority documents have been received.

2.☐ Certified copies of the priority documents have been received in Application No. _____.

3.☐ Copies of the certified copies of the priority documents have been received in this National Stage application from the International Bureau (PCT Rule 17.2(a)).

* See the attached detailed Office action for a list of the certified copies not received.

Attachment(s)

1) ☒ Notice of References Cited (PTO-892)
2) ☐ Notice of Draftsperson's Patent Drawing Review (PTO-948)
3) ☒ Information Disclosure Statement(s) (PTO-1449 or PTO/SB/08) Paper No(s)/Mail Date *25 February 2004*.
4) ☐ Interview Summary (PTO-413) Paper No(s)/Mail Date. _____.
5) ☐ Notice of Informal Patent Application (PTO-152)
6) ☐ Other: _____.

DETAILED ACTION

Claim Rejections - 35 USC § 112

The following is a quotation of the second paragraph of 35 U.S.C. 112:

> The specification shall conclude with one or more claims particularly pointing out and distinctly claiming the subject matter which the applicant regards as his invention.

1. Claims 2 and 7 are rejected under 35 U.S.C. 112, second paragraph, as being indefinite for failing to particularly point out and distinctly claim the subject matter which applicant regards as the invention.

Regarding claim 2, it is unclear in "forming the **electrode** on the surface selectively nitrided" which electrode is being addressed. For purpose of this Office Action, it is assumed that "electrode" refers only to the gate electrode.

Regarding claim 7, it is unclear the mechanism by which "the atomic nitrogen transmitted **by** the insulation or aluminum film contacts the surface". For purpose of this Office Action, the limitation is treated as the atomic nitrogen contacts the surface by ion implantation through the insulation or aluminum film.

Claim Rejections - 35 USC § 102

The following is a quotation of the appropriate paragraphs of 35 U.S.C. 102 that form the basis for the rejections under this section made in this Office action:

> A person shall be entitled to a patent unless –
>
> (e) the invention was described in (1) an application for patent, published under section 122(b), by another filed in the United States before the invention by the applicant for patent or (2) a patent granted on an application for patent by another filed in the United States before the invention by the applicant for patent, except that an international application filed under

the treaty defined in section 351(a) shall have the effects for purposes of this subsection of an application filed in the United States only if the international application designated the United States and was published under Article 21(2) of such treaty in the English language.

2. Claims 1, 2 and 4 are rejected under 35 U.S.C. 102(e) as being anticipated by Makita (U.S. Pub. 2004/0192043).

Regarding claim 1, Makita [Figure 8C] discloses a method of manufacturing a semiconductor device including a gallium nitride related semiconductor material, the method comprising:

preparing a substrate [12 of Figure 8C] having a surface [22 of Figure 8C] that is gallium nitride related semiconductor material;

decomposing a nitrogen-containing gas in a catalytic reaction, to produce atomic nitrogen [p. 5, paragraph 53];

contacting the surface with the atomic nitrogen to nitride the surface [p. 5, paragraph 53]; and forming, on the surface, a gate electrode [38 of Figure 8C] and source [26 of Figure 8C] and drain [28 of Figure 8C] electrodes on opposite sides of the gate electrode;

Regarding claim 2, Makita [p. 2, lines 15-20 of paragraph 16] discloses wherein including, in the nitriding, selectively nitriding the surface, and forming the electrode on the surface selectively nitrided.

Regarding claim 4, Makita [Figure 8C] discloses a method of manufacturing a semiconductor device including a gallium nitride related semiconductor material, the method comprising:

preparing a substrate [12 of Figure 8C] having a surface [22 of Figure 8C] that is gallium nitride related semiconductor material;

forming, on the surface, a gate electrode [38 of Figure 8C] and source [26 of Figure 8C] and drain [28 of Figure 8C] electrodes on opposite sides of the gate electrode [p. 2, lines 1-5 of paragraph 27 and p. 4, lines 1-5 of paragraph 50, disclose the electrodes are formed prior to the nitriding step];

decomposing a nitrogen-containing gas in a catalytic reaction to produce atomic nitrogen [p. 5, paragraph 53];

contacting the surface, at an area between the source electrode and the gate electrode and at an area between the drain electrode and the gate electrode, with the atomic nitrogen, to nitride the surface [p. 2, lines 10-20 of paragraph 16].

Claim Rejections - 35 USC § 103

The following is a quotation of 35 U.S.C. 103(a) which forms the basis for all obviousness rejections set forth in this Office action:

> (a) A patent may not be obtained though the invention is not identically disclosed or described as set forth in section 102 of this title, if the differences between the subject matter sought to be patented and the prior art are such that the subject matter as a whole would have been obvious at the time the invention was made to a person having ordinary skill in the art to which said subject matter pertains. Patentability shall not be negatived by the manner in which the invention was made.

3. Claims 3 and 5 are rejected under 35 U.S.C. 103(a) as being unpatentable over Makita in view of Melas (U.S. Pub. 2005/0136627).

Regarding claims 3 and 5, Makita fails to disclose wherein including, in the nitriding, forming an aluminum layer on the surface and nitriding a surface of the aluminum layer. However, Melas [Fig 1, and p. 2, paragraph 17] discloses "wherein said metal component layer comprises Aluminum". Melas teaches

forming an aluminum layer, on the surface, and that a surface of the aluminum is nitrided [Melas, p. 2, paragraph 43].

It would have been obvious to one of ordinary skill in the art at the time of the invention was made to incorporate the teachings of Melas into the method of Makita to form an aluminum layer on the surface of the gallium nitride related semiconductor material. The ordinary artisan would have been motivated to modify Makita in the manner set forth above for at least the purpose of protecting the surface from decomposition during the nitriding process [Melas, p. 1, paragraph 7]. Additionally, aluminum is the preferred material for this application as the lattice constant and crystal structure of AlN are very similar to GaN, and the two nitrides are completely miscible in all proportions [Melas, p. 2, lines 10-13 of paragraph 42].

4. Claim 6 is rejected under 35 U.S.C. 103(a) as being unpatentable over Makita in view of Kikkawa (U.S. Pub. 2004/0144991).

Regarding claim 6, Makita [Figure 8C] discloses a method of manufacturing a semiconductor device including a gallium nitride related semiconductor material, the method comprising:

preparing a substrate [12 of Figure 8C] having a surface [22 of Figure 8C] that is gallium nitride related semiconductor material;

forming, on the surface, a gate electrode [38 of Figure 8C] and source [26 of Figure 8C] and drain [28 of Figure 8C] electrodes on opposite sides of the gate electrode [p. 2, lines 1-5 of paragraph 27 and p. 4, lines 1-5 of paragraph 50, disclose the electrodes are formed prior to the nitriding step];

decomposing a nitrogen-containing gas in a catalytic reaction to produce atomic nitrogen [p. 5, paragraph 53];

contacting the surface, at an area between the source electrode and the gate electrode and at an area between the drain electrode and the gate electrode, with the atomic nitrogen, to nitride the surface [p. 2, lines 10-20 of paragraph 16].

Makita fails to disclose forming one of an insulating film and an aluminum film covering all of the surface. However, Kikkawa [Fig 7B, p. 5, paragraph 73] discloses "an SiN film 58... is formed on the entire surface...".

It would have been obvious to one of ordinary skill in the art at the time of the invention was made to incorporate the teachings of Kikkawa into the method of Makita to form an insulation film covering all of the surface of the gallium nitride related semiconductor material. The ordinary artisan would have been motivated to modify Makita in the manner set forth above for at least the purpose of surface preparation for additional processing steps such as etching or depositing additional layers prior to nitriding [Kikkawa, p. 5, paragraph 74].

5. Claim 7 is rejected under 35 U.S.C. 103(a) as being unpatentable over Makita and Kikkawa in view of Nguyen (U.S. Pat. 5766695).

Regarding claim 7, Makita and Kikkawa fail to disclose wherein, in the nitriding, the atomic nitrogen transmitted by the insulation or aluminum film contacts the surface so the surface is nitrided. However, Nguyen [Fig 4, column 4, lines 48-64], discloses nitriding the surface through an insulation or "dummy layer" by ion implantation.

It would have been obvious to one of ordinary skill in the art at the time of the invention was made to incorporate the teachings of Nguyen into the method of Makita and Kikkawa to nitride the surface of the gallium nitride related semiconductor material through an insulation or aluminum film by ion implantation. The ordinary artisan would have been motivated to modify Makita and Kikkawa in the manner set forth above for at least the purpose of improving the controllability of the nitriding process as well as preventing the nitrogen from escaping from the surface layer during subsequent high temperature processing steps [Nguyen, column 5, lines 11-19].

Conclusion

6. Any inquiry concerning this communication or earlier communications from the examiner should be directed to Bac H. Au whose telephone number is 571-272-0237. The examiner can normally be reached on Mon-Fri 8-5.

If attempts to reach the examiner by telephone are unsuccessful, the examiner's supervisor, Amir Zarabian can be reached on 571-272-1852. The fax phone number for the organization where this application or proceeding is assigned is 703-872-9306.

GEORGE ECKERT
PRIMARY EXAMINER

Information regarding the status of an application may be obtained from the Patent Application Information Retrieval (PAIR) system. Status information for published applications may be obtained from either Private PAIR or Public PAIR. Status information for unpublished applications is available through Private PAIR only. For more information about the PAIR system, see http://pair-direct.uspto.gov. Should you have questions on access to the Private PAIR system, contact the Electronic Business Center (EBC) at 866-217-9197 (toll-free).

BHA

GEORGE ECKERT
PRIMARY EXAMINER